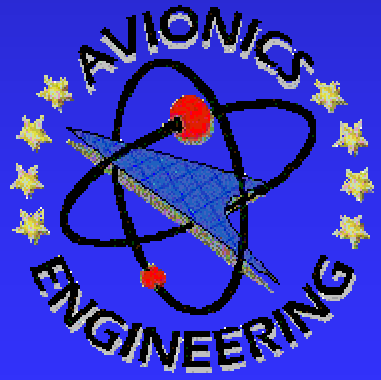
Ensuring Viable Combat Avionics

Bandwidth Extension Using Mil-Std-1553 Interface

Bill Wilson ASC-ENAS

Wright-Patterson AFB, Ohio
Telephone (937) 255-4002



Environment

- Legacy Aircraft Remain Key Part of Budget Process
  - Most have 1970's Vintage Mil-Std-1553 Interface
- Growth to Meet Information Needs
  - Changing Core Architecture is Difficult
    - Mods Impact Existing Busses/Require New Busses
    - Depot Modifications Normally Required
  - Hardware/Software (Re)Qualification Drives $ & Schedule
- DoD has Increasing Dependence on Commercial Technology

Capability Drivers

- Global Grid
- Constellation/Horizontal Integration
  - Line of Sight/Satellite Connectivity
  - Time Critical Targeting/Strike
    - Real Time Images/Video in Cockpit
    - Cooperative Tactics/Information Exchange
- GANS/GATM
- Managing DMS/Obsolescence/Viable Tech Base

Acquisition Upgrade Examples

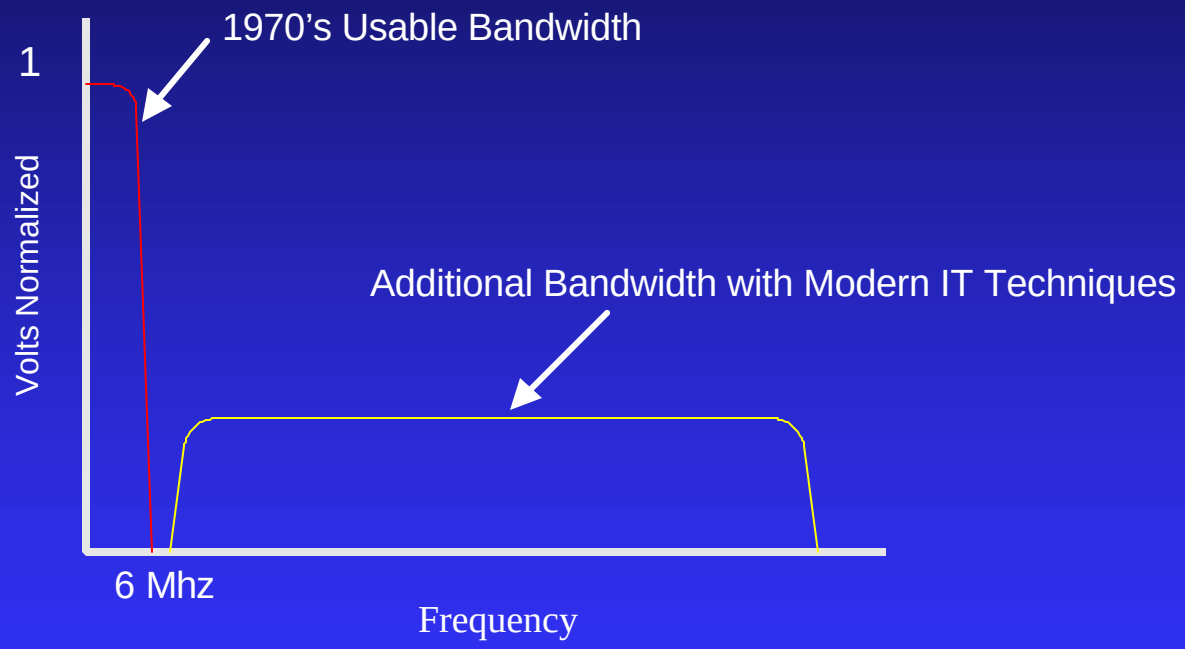
- F-117
- B-2
- F-16
- F-15
- C-17

Is It Possible to Apply Commercial IT to Existing Interfaces?

Yes!

This is How It Works

Current Mil-Std-1553 Interface Limited to ~1 MBPS



Legacy 1553 Implementation Uses A Fraction of What's Available

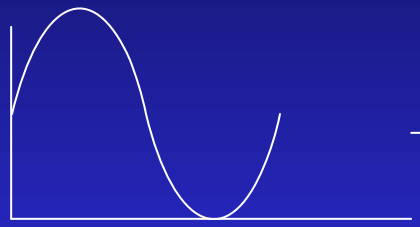
Waveforms Have Evolved

1970's Technology

- Simple Sinusoids Form Information "Bits"

10 volts P-P

1 State
1 Amplitude
1 Bit Per Time Increment

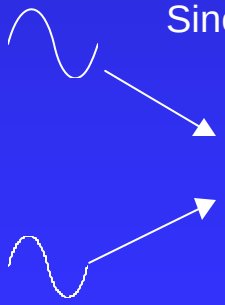


→ Single Band

2002 Technology

- Complex Waveforms Form Information "Symbols"

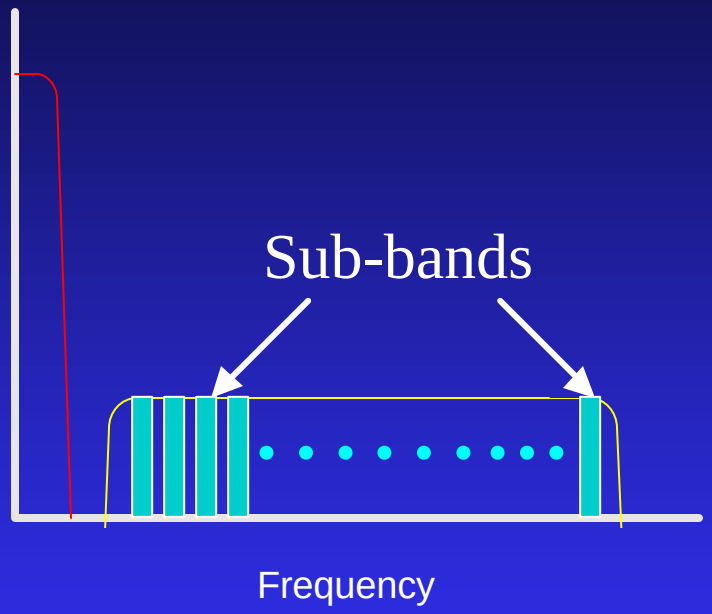
Two States
Sines and Cosines Form 2^x Complex Amplitudes



Vector Add →

Symbol → Sub Band

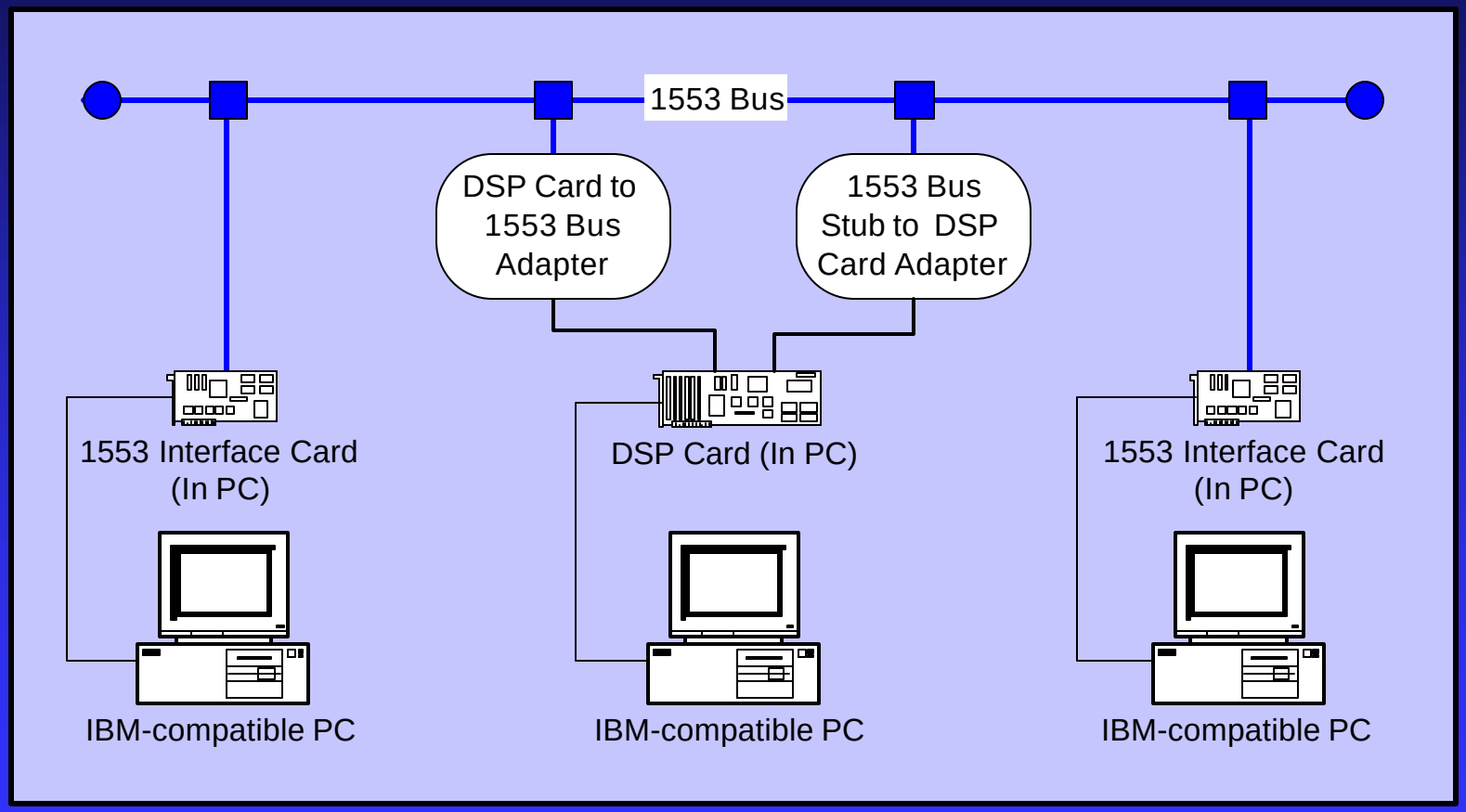
Multiple Sub Bands Allow Many Paths In One Wire



- Frequency-division multiplexing creates multiple sub-bands
- Symbols are Amplitude & Phase Encoded 2^x
- Symbols Transmitted on Each Band
- High Speed Clock Rate
- Digital Processing/Matched filters for each sub-band
- Error detection and correction
- Effective Data Rate – 300 to 600 Million Bits per Second

Demonstration Results

Hardware Test Configuration



Demonstration Testing and Simulation Results

- Bandwidth:
  - 296 Mbps Tested (rapid prototype hardware)
  - >500 Mbps calculated & simulated
- Cable length: 300 feet of 1553 wire
- Coupler compatibility:
  - 6 F-16 couplers “matrices” tested
  - 2 Coupler and 31 Coupler Simulated
- Low Data bit error ratio:
  - $<1x10^{-12}$ Measured at 200 Mbps
  - Simulations Support Similar Results for Higher BWs

Program Plan

Gov't Mgmt → Contractor Mgmt

Brass Board Demo
+ Draft Std Outline

6 months

Conceptual Design

Prototype Hardware
H/W & S/W Integration
EMI/EMC Test, Draft Std

15 months

Updated Draft Std, Test Procedures, Handbook
A/C SIL Integration

12 months

Low Risk for A/C Integ.

Full Qual starts after two Years and lasts for about 6 months

Qualification Testing

Flight Test

Summary of Objective Capability

- Upgrade Existing 1553 Effective Network Capacity
  - ~ 500x
- Use commercial bus interfaces on 1553 wire
  - Standard Ethernet (10, 100 Mbps)
  - Gigabit Ethernet
  - Fibre Channel
  - Firewire
  - Mix and match above
- Minimum Impact Growth and Modernization
  - No Depot Rewiring
  - Retain Legacy Subsystems
  - Add New
    - Send video over 1553
    - Digital Map
    - etc

Recommended Actions

- Provide funding to develop concept
- Work with prime contractors
  - Identify needs
  - Integrate into SILs
  - Assess performance
  - Support adoption of new standards
- Integrate into viable combat avionics plans

AF Points of Contact

- Mike Carpenter
  - Technical Director ASC/ENA
  - 937-255-9299
- William Wilson
  - Technical Advisor, Avionics Architecture ASC/ENAS
  - 937-255-9274